

PAPERS ON CLIMATOLOGY IN RELATION TO AGRICULTURE, TRANSPORTATION, WATER RESOURCES, ETC.

CHARTS OF THE ATMOSPHERE.¹

Review by ALEXANDER G. McADIE, Professor, Weather Bureau, San Francisco, Cal.

This volume by Prof. A. Lawrence Rotch and Mr. A. H. Palmer at once suggests to every meteorologist a somewhat similar undertaking when the surface winds and ocean currents were charted by Maury 50 years ago. The present book, however, forces a recognition of even greater possibilities than the navigational charts promised, for while the ocean binds the nations water is not man's natural environment and the air is. Men had sailed the seas for ages before the physical geography was written; but men are only now beginning to fly, and what the future holds for us along these lines no one can predict.

The charts in this volume are primarily designed for the use of aviators and aeronauts. So far as we know they are the first issued for this purpose. The results of the many observations made during the past 20 years by the staff of the Blue Hill Observatory in the United States and on the Atlantic Ocean in exploring the air have been used almost exclusively and to good advantage.

At the outset we notice the distinction made between aeronauts and aviators, the former being balloon pilots and the latter pilots of flying machines heavier than air. Twenty-four charts are published, each accompanied with a page of explanatory text. The first chart gives relative heights, atmospheric density, and temperature. The heights are given only in English measures, and it would be an improvement if in subsequent editions corresponding values in the metric system were given.

Possibly a parallel column showing dynamic meters and equivalent pressures in millibars should be added. This opens up a matter of the utmost importance, namely, shall scientific units or units that at least make a pretense of precision be used *now* or shall we continue to use the old and cumbersome units and clumsy tables for conversion. This it seems to us is the only point on which the authors can be justly criticized, for in no place do they use anything but the old English units. Perhaps the authors felt that as the book was intended for American airmen it was better to keep to the units in common use and that the introduction of absolute units would not be desirable at the present time. Mr. Rotch's work abroad, however, is so well known and his familiarity with kite and balloon data so great that it seems strange not to find incorporated in this work at least equivalent values in units that are comparable and have a scientific basis. And it is only a question of time before the new notation must be used, for the old units retard rather than make for progress. The arguments in favor of the new pressure unit, i. e., where the pressure is represented in units of force and the value of 1,000,000 dynes taken as a standard, and all pressure variations given in percentages of this, are obvious; and the terms millibar instead of millimeter, centibar and decibar instead of others are daily appearing in the literature of meteorology. Tables are already published for the quick conversion of geo-

metric to dynamic values. The reason for introducing the dynamic meter is simply because the value of the acceleration of gravity varies. As Bjerknes pointed out in his recent *Dynamic Meteorology*, the surface of equal heights is a slanting surface on which equilibrium is not possible under the sole action of gravity. On a surface of equal height above sea level a ball would roll from the pole to the Equator and on a surface of equal depth below sea level it would roll from the Equator to the pole. Therefore surfaces of equal height are not suitable as coordinate surfaces in problems connected with the dynamics of the atmosphere. To perform the same amount of work unit mass must be lifted higher at the Equator than at the pole. The whole conception is interesting and an idea of its far-reaching consequences can be obtained by thinking of a dynamic map in which the height of a mountain would be measured not by the vertical distance from sea level to summit, but by the proper value of the work done in reaching the summit.

The text accompanying the various charts is well written. The diagrams are explained in an easy and natural way, and there are many references to experimental facts which win and hold the interest of the lay reader. For the professional airman the charts are without question a "vade mecum." Of course the obvious weakness of all such charts from the professional air navigator's point of view is that they represent average conditions, which may not even be the probable conditions, and obviously they can not be expected to meet the individual requirements. As Prof. Rotch very wisely puts it:

In the air as on the earth it is the unexpected which determines the result.

The charts are all valuable and are particularly strong in the matter of wind velocities at various levels and the frequency of certain winds at certain seasons. Of course data are chiefly those relating to horizontal movements. Ascensional air currents, and more especially the peculiar intermittent pulses which we do not yet adequately recognize nor automatically record, are, however, not forgotten. In the text accompanying chart 8 it is shown that intermittent ascending currents occurring during the daytime are strongest in summer and when it seems to be nearly calm. The upper limit of these currents is usually shown by the tops of cumulus clouds in which descending currents may cause vortices about horizontal axes. Cumulus clouds therefore indicate—

that although the horizontal velocity of the air below them is less than the average, the conditions are unfavorable for aerial experiments, especially near the clouds.

This we think is a matter of great importance to aviators, and doubtless as the years go by we shall find that there are certain hours of the day or night when the conditions are favorable for aviation and other periods

¹ Charts of the atmosphere for Aeronauts and Aviators, by A. Lawrence Rotch and Andrew H. Palmer. Four to twenty-four full-page charts. John Wiley & Sons, 1911.

when there will be an element of danger. The vertical stability of the air is greatest during the night.

Extremely interesting are charts 21 and 22. The former enables the aerial navigator who has studied the pressure distribution from the daily weather map to forecast the changes of wind at different heights. In the case of low-pressure areas the closer the isobars the stronger will be the wind and the more nearly parallel or concentric to them will be its direction, which turns to the right hand with increasing height in the front half of the low pressure and slightly to the left hand in the rear half. Chart 24 gives the aerial routes of the summer across the north Atlantic. Courses are indicated and appropriate lines show the distance traveled by each wind and the direction in which the airship must be headed to maintain the course; also the distances which the motor acting alone would drive it. These forces, represented by the adjacent sides of a parallelogram, give the resultant progress. This and the course to be steered are readily found by means of an instrument devised by Prof. Rotch and constructed by Casella, in London. When the wind and motor act together the resultant is their sum and when opposed the difference. For simplicity the winds are concentrated in eight directions.

The work as a whole is a practical application of the knowledge deduced from many years' work at Blue Hill Observatory in the measurement of cloud heights and velocities, as well as other problems in meteorology which were not undertaken in connection with aerial navigation. The volume shows how valuable the work of the investigator becomes in directions never dreamed of when undertaken. The observatory has thus fur-

nished data of the greatest importance to aviators and aeronauts. The book marks an epoch in aerophysics. It is undoubtedly the forerunner of elaborate charts of the air, even as the pilot charts followed from Maury's work.

CHARTS.

1. Relative heights, atmospheric density, and temperature.
2. Average temperature, barometric pressure, wind velocity, and pressure up to 30,000 feet.
3. Maximum wind velocities and pressure up to 30,000 feet at Blue Hill.
4. Wind pressures for constant velocities up to 30,000 feet.
5. Wind pressures for constant velocities up to 10,000 feet.
6. Monthly temperatures up to 12,000 feet at Blue Hill.
7. Monthly wind velocities up to 12,000 feet at Blue Hill.
8. Hourly wind velocities up to 10,000 feet at Blue Hill.
9. Frequency of constant wind velocities, 1,000 to 10,000 feet, at Blue Hill.
10. Frequency of winds at Blue Hill, 650 feet.
11. Velocity of winds at Blue Hill, 650 feet.
12. Frequency of winds at Blue Hill, 1,650 feet.
13. Velocity of winds at Blue Hill, 1,650 feet.
14. Frequency of winds at Blue Hill, 3,300 feet.
15. Velocity of winds at Blue Hill, 3,300 feet.
16. Frequency of winds at Blue Hill, 6,600 feet.
17. Velocity of winds at Blue Hill, 6,600 feet.
18. Frequency of winds at Blue Hill, 10,000 feet.
19. Velocity of winds at Blue Hill, 10,000 feet.
20. Wind velocity and direction up to 13,000 feet at St. Louis.
21. Winds at various heights as related to barometric pressure at the ground.
22. Frequency of winds in the northeast trade region of the Atlantic Ocean.
23. Velocity of winds in the northeast trade region of the Atlantic Ocean.
24. Aerial routes in summer across the north Atlantic Ocean.